serving her as food; and when the intensity of these volatile substances is very high, i.e. when the insect is on the material, the egg-laying mechanism of the fly is automatically set in motion. Thus the common house-fly will deposit its eggs on decaying meat but not on fat; but it will deposit it on objects smeared over with assafoetida, on which the larvae cannot live. It seems that the female insect lays her eggs on material for which she is positively chemotropic, and this is generally material which she also eats. The fact that such material serves as food for the coming generation is an accident. Considered in this way, the mystic aspect of the care of insects for the future generation is replaced by the simple mechanistic conception of a tropistic reaction."

The author's treatment of memory images and the general phenomena of association seem to indicate a negative psychiotropism on his part which results in "forced" conclusions.

It is not often, in spite of his mechanistic determinism, that the author's logic actually nods. But surely the fact that "Passenger pigeons when reared by ring doves refuse to mate with their own species but mate with the species of their foster parents" does *not* "show incidentally that racial antagonism is not inherited but acquired." The most that it can "show" is that if inherited in any degree such aversion can be lost thru experience.

The book is wonderfully suggestive and is a strong exposition of the purely mechanist thesis.

Monographs on Experimental Biology: Volume I, Forced Movements, Tropisms, and Anima Conduct, by Jacques Loeb. 210 pages, illustrated. J. B. Lippincott and Company, Philadelphia. 1918. Price $2.50.

II. THE ELEMENTARY NERVOUS SYSTEM

This is the second in the series of volumes summarizing the results in various special fields of experimental physiology. It is written with the directness and clearness characteristic of Professor Parker's writings.

"Elementary" in this title is used in a strict sense, as the author confines his discussion to the conditions found in the three simpler phyla of multicellular animals,—the sponges, coelenterates, and ctenophores.

In an introductory chapter the author calls our attention to the fact that we take an anthropomorphic view of the behavior and capacities of the lower animals because our first studies of nervous structure and phenomena were done upon man and the higher animals. In this connection he emphasizes that the unitary neuro-muscular mechanism of the higher animals, consisting as it does of a group of receptors connected with a well-organized adjustor or internuncial group of neurones which in turn control a specialized effector apparatus, is found only in the differentiated animals. While elementary in relation to the whole complex system, this reflex arc is not elementary in a primitive sense.

For the most part in the groups studied the neuro-muscular system consists of many peripheral sensory cells, often with well specialized receptive portions, with deep branching ends which connect more or less directly with the muscular elements without any complex adjusting or central organ. This latter may be fairly looked upon as a later, indeed the latest, and higher step in the evolution of the apparatus. And yet, as we might well expect, conditions are found which suggest gradations toward this higher type.

This direct connection of receptors and effectors is itself not the primitive condition. The author conceives that the antecedent of this apparatus is a still simpler condition in which is only the effector or muscular element. With this foundation of independent effectors, themselves directly but slowly sensitive and responsive to the essential tensions and stresses, the gradual differentiation of the other parts as accessory to them is entirely plausible.

Dr. Parker organizes his presentation of the subject on this interpretation of his findings by discussing in Section I the "Effector Systems," as in the sponges and in certain independent effector systems of higher animals; in Section II, the "Receptor-Effector Systems" as illustrated in the Sea-anemones, Jelly fishes and Hydroids; and in Section III, with certain anticipations in later chapters of Section II, he outlines a scheme correlating these more primitive conditions with one another and with those animals in which the adjustors or central organs also appear.

By a series of experiments upon suitable sponges it was found that the common flesh is contractile, the oscula open and close, the incurrent pores may close either by the modified ameboid motion

of the pre-membrane or by the contraction of a sphincter-like band of cells in the wall of the canal itself. These operations may be studied directly or by the modification of the currents of water maintained thru the sponge by the flagellate cells in the specialized canals of the sponge. Various, tho somewhat limited stimuli may operate in producing response in these effectors,—as presence or absence of sea water, existence of currents in the water, injuries, and changes in the chemical condition of the water. Critical experiments, detailed at length, warrant the conclusion that the stimuli operate directly upon the simple independent contractile elements, and not thru specialized receptors.

In Chapter IV it is shown that such independent muscular effectors are not confined to sponges but are present also in certain organs of higher animals. The sphincter of the pupil of the eye, the amnion of the chick, the embryonic heart of vertebrates (and probably in some degree the adult heart) show this immediate responsiveness of muscle without the intervention of special sensory elements. These conditions may also be accompanied by ordinary nervous control of the muscles.

The transmission of impulses from one part of the sponge to another takes place by a sluggish neuroid rather than a nervous process. This is protoplasmic and primordial, and apparently back of the more specialized nervous transmission. This too is a condition retained in certain effectors in the higher animals. Evidences of such neuroid transmission in the absence of actual nervous structures are seen in the coördinations of ciliary action in many higher animals including vertebrates, and in the swimming plates of Ctenophores.

Section II with eight chapters deals with the more prompt and effective receptor-effector system as illustrated in the Coelenterates. There is added here a more specialized sensory surface fitted to receive more exactly the various stimuli and to transmit their influence thus indirectly to the responding apparatus. In the sea-anemones there are four types of effectors:—the mucous glands, the cilia, the nettle cells, and the rather numerous special sets (13 in *Metridium*) of muscle fibres. Among these only the muscles give any experimental evidence of nervous control. The others are independent effectors.

Various observations show that there is wide spread transmissive connection of a nervous kind between the epithelium and the deep

muscular layer which makes it possible to bring the whole muscular effector apparatus into response by a surface stimulus at any point of the body. The author holds that this nerve net is not in the supposedly nervous layers of ectoderm and entoderm, but rather in the supporting lamella between them.

In Jelly fishes there is both an increased specialization of the receptor system (e.g., the marginal sensory bodies) and of the muscular effectors, as well as of the nerve net which connects them. There is in them a corresponding promptness of response, with a remarkable coördination of the total bodily reaction thru a very definite wave of contraction evidently made possible by the nerve net.

In Chapters IX and X the author traces the contrasts and correspondences between this nerve net as the main connecting apparatus in Coelenterates and its existence in special organs in the higher forms—as in the heart and intestine of vertebrates (often side by side with the neurone synaptic system). This nerve net is particularly suitable to autonomous structures and organs and to situations in which the transmission needs to be diffuse and general rather than to produce specific and local reflexes. Yet in even such highly autonomous organs as tentacles in the Coelenterates show themselves to be, there is some degree of physiological polarity present, in that transmission occurs more freely in one direction than in others; and they may fairly be said to show evidences locally of the beginnings of nervous organization of a grade higher than the diffuse nerve net.

Functionally the transition to the condition which we know as reflexes, in which a local and particularized muscular response follows regularly from equally local and specific stimulus might well come in this gradual way thru increased polarization of originally diffuse apparatus. A localized esophageal response in *Metridium* by a specific stimulation of the tentacles by fish meat has all the earmarks of such a reflex—superimposed upon the more diffused net reactions.

Chapters XI and XII analyze some of the more complex effective operations of Actinians (in which field the author and his students have done leading and conclusive work) to determine whether these indicate any evidences of the higher internal coördinative and unifying functions which characterize those animals having a central apparatus. Among the most promising of these are the operations

of feeding, rhythmic or other contractions and expansions, the creeping activity of the pedal disc, and the general modifiability of behavior thru the experiences of the animals. No such associative results are revealed as would imply a nervous integration higher than the net would supply. The best that can be said seems to be that there is a small group of feeding activities which localize as reflexes.

Chapter XIII is devoted to Hydroids, particularly illustrated by *Corymorpha*, in an effort to discover whether these animals, regarded as more primitive than the Actinians, have a receptor-effector apparatus more simple than they, and thus furnish a clue to the possible evolution of the higher coelenterate condition from that in the sponges. In these forms the muscular effector system reduces essentially to an ectodermal longitudinal system and a circular entodermic one. These are further differentiated into the stalk muscles, those of the hypostomial ("proboscis") extension of the stalk, and those of the two groups of tentacles. Of these muscles the circular entodermic ones seem to be directly stimulated (i.e., without nervous intermediation) and therefore are more like the slow acting, primitive type found in sponges. They operate in connection with the vacuolated cells to bring the hydroid back to it elongated form. The ectodermic muscles on the other hand are relatively prompt in action and are controlled by a nervous system of ectodermic receptors and a nerve net—as in actinians. *Corymorpha* also shows specialized reflexes analogous to those in *Metridium*. The author holds that *Corymorpha* evidences behavior and nervous organization of *reduced actinian type* rather than intermediate between the sponges and the actinians.

Section III, which comprises one final chapter of "Conclusions" is devoted to giving an outline of the differentiating steps in passing from the elementary independent effecton to the complex central nervous system of the higher animals. The whole chapter is a concise, condensed outline, and no brief abstract of it can do justice to its lucid presentation. It can serve only as a Table of Contents to the chapter.

1. The starting point in the evolution of the nervous system in metazoa is the simple independent effector of smooth muscle cells. Such an apparatus is functionally limited to the reception of the grosser, more physical types of stimulus, is slow and sluggish in its responses, and the diffuse transmission is of a protoplasmic neuroid

rather than specialized nervous type. This condition is realized in sponges.

2. Around this starting point of response the receptor system next develops, making for promptness and elaboration of reception of stimuli. In this way comes distinctions in the categories of possible stimulation, and extension of its range to milder and more refined types of stimulus. Hypothetically, there are several possible steps in the elaboration of such a receptor-effector system. The first of these would be the immediate connection of nearby epithelial cells with the Effectors. This simple condition is as yet hypothetical. The simplest form actually found is where the inner branching ends of the receptors connect not alone with the muscles but with one another in a more or less complex network. This is illustrated in the tentacles of Actinians. Functionally this increases the dispersal of the effective results of stimulation in a diffuse way to many muscles, and gives a nervous instead of a neuroid character to transmission. A further complication of this is seen where special branched cells are connected with this nerve net. These have been called "ganglia." The author thinks that the term "protoneurone" may rightly express their nature. This is illustrated in the Coelenterates at many points. There are experimental evidences that a still further specialization of this nerve net is in limiting or specializing the routes and directions of transmission. Functionally the result in such as we usually describe under the term reflexes. It involves a localized response as characteristic of a localized stimulus. This involves some sort of polarity in the nerve net. This is found in certain actinian reactions. All of this is without any organization or any responses which simulate the central nervous stations of the higher animals.

3. Broadly anticipating the transitions to anatomical and functional conditions in the perfected receptor-adjustor-effector scheme the author suggests the main changes to be: the inward migration and concentration of the primary receptors and of the diffuse net elements into sheets, bands, and masses; more elaborate and perfect polarization and the increase of the special reflexes; the appropriation in many cases of secondary sensory cells by which the receiving function is again differentiated; and perhaps most significant of all the introduction of the neurone-synaptic apparatus whereby the route of the passage of impulses is more definitely determined. This carries

the polarization phenomenon a step further. There follows too in higher forms, apparently, the mechanism of the control of synaptic or other resistances by which inhibition or augmentation of impulses takes places.

The book will aid the general teacher and student of biology at a most interesting point.

Monographs on Experimental Biology, Volume II: The Elementary Nervous System, by G. H. Parker. 229 pages, illustrated. J. B. Lippincott, Philadelphia, Price $2.50.